

## **REMARKS**

Claims 16-32 are pending in this application. By this Amendment, claims 16, 17 and 30 are amended. No new matter has been added.

The Office Action rejects claim 16 under 35 U.S.C. § 102(e) as being anticipated by Zhang et al. (U.S. Patent No. 5,766,344). The Office Action also rejects claims 17-32 under 35 U.S.C. § 103(a) as being obvious over Zhang et al. in view of one or more of Fan et al. (U.S. Patent No. 4,309,225), Asakawa et al. (U.S. Patent No. 5,795,385), Selvakumar et al. (U.S. Patent No. 5,633,194), Ichikawa et al. (U.S. Patent No. 5,484,746) and Krimmel (U.S. Patent No. 4,140,546). These rejections are traversed.

The presently claimed invention is directed to a crystalline silicon film forming method including preparing a film forming apparatus having a silicon film forming vacuum chamber for forming a crystalline silicon film on a substrate, and provided with a film forming device for forming a pre-film of the crystalline silicon film on the target surface of the substrate, and an energy beam radiating device for irradiating said pre-film with an energy beam for crystallizing the pre-film. As amended, claim 16 (and dependent claims 18, 20, 22, 24, 26, 28, 29, 31 and 32), further require that the method is conducted without dehydrogenation processing.

The newly cited Zhang et al. discloses a process in which (a) A non-crystalline (amorphous or microcrystal) silicon hydride film having a Si-H bond of a high density is formed on a substrate..." (column 2, lines 15+) and "(c) A non-crystalline (amorphous or microcrystal) silicon film is crystallized by a laser irradiation or a heating with the vacuum or inactive gas atmosphere maintained" (column 3, lines 27+). Zhang et al. further disclose that "an equipment having a chamber, which is provided with a high vacuum

exhaust system, a quartz window for laser irradiation, a heating apparatus for heating process and the like, is needed” (column 4, lines 16-19).

Zhang et al. appears to be related to the prior art described on page 3, line 10 to page 4, line 9 of the present specification. As noted in this section of the present specification, for the Zhang et al. type of process, “the amorphous silicon film contains a large amount of hydrogen mixed therewith [such that] the quality of the film would be impaired due to bumping of hydrogen if the film were irradiated with the laser beam as it was. Therefore, heat treatment must be effected on the amorphous silicon film formed on the substrate for removing the hydrogen, and thus time-consuming processing is required” (page 4, lines 3-9 of the present specification).

In fact, Zhang et al. clearly requires a step (b) where “[h]ydrogen in a non-crystalline (amorphous or microcrystal) silicon film is expelled from the silicon film and a high-density dangling bond is formed in silicon, by effecting a heat treatment (thermal annealing) of the non-crystalline (amorphous or microcrystalline) silicon film formed in the [above-described step (a)]” (Zhang et al. column 2, lines 42+). According to Zhang et al., “[t]his heating process is to be carried out, so as to produce a lot of dangling bond, by releasing hydrogen...” (column 3, lines 4-5).

In contrast, in the process described in the present specification, “dangling bonds in the silicon-silicon network and defects in the film are suppressed” (page 14, lines 15-16 of the present specification). Further, “it is possible to suppress impairment of the film quality, which may be caused by bumping of hydrogen during irradiation with the energy beam, without requiring dehydrogenation processing such as heating before the irradiation

with energy beam [and this] improves the productivity” (page 13, line 24 to page 14, line 2 of the present specification).

Thus, Zhang et al. it clearly distinguished from present claims 18, 20, 22, 24, 26, 28, 29, 31 and 32, with the amendment to claim 16 to define that the method is conducted “without dehydrogenation processing.”

Regarding claim 17 (and the dependent claims thereof), because Zhang et al. requires two different heating temperatures, including the step (a) where hydrogen is contained in the “film as much as possible” (column 2, lines 29-30) and heating step (b) to remove hydrogen, Applicants respectfully submit that it would be difficult (and probably impossible) to form the pre-film on one portion of the substrate while concurrently crystallizing already formed pre-film on another portion of the substrate, while also including a step of removing hydrogen. Thus, Applicants respectfully submit that Zhang et al. could not be modified without destroying the intended object thereof by removing the removing hydrogen heating step.

Thus, claim 17, which has been rewritten in independent form without any limitations added to claim 16, is clearly distinguishable from Zhang et al., which could not have been non-obviously modified to meet the limitations of claim 17.

Fan et al. discloses a method of crystallizing amorphous film with a moving energy beam. Asakawa et al. describes a method of forming single-crystalline thin film by beam irradiation. Selvakumar et al. teach low temperature ion-beam assisted deposition methods. Ichikawa et al. teach a process for forming a semiconductor thin film.

As none of these references teach or suggest that the dehydrogenation step of Zhang et al. should not be conducted, all of these references fail to overcome the

deficiencies of Zhang et al. with reference to amended claim 16 (and the dependent claims thereof) and to non-amended claim 17 (and the dependent claims thereof). However, even if one or more of these references did teach or suggest not conducting a dehydrogenation step, Applicants respectfully submit that it would not have been obvious to apply such a teaching to Zhang et al. since conducting such a step would destroy the principle of operation of Zhang et al.

Applicants respectfully submit that this application is in condition for allowance and such action is earnestly solicited. If the Examiner believes that anything further is desirable in order to place this application in even better condition for allowance, the Examiner is invited to contact Applicants' undersigned representative at the telephone number listed below to schedule a personal or telephone interview to discuss any remaining issues.

In the event this paper is not timely filed, Applicants respectfully petition for an appropriate extension of time. The Commissioner is authorized to charge payment for any additional fees which may be required with respect to this paper to Counsel's

Deposit Account 01-2300, referring to client-matter number 107351-00011. Thus, please charge any fee deficiency or credit any overpayment to Deposit Account No. 01-2300, making reference to Attorney Docket No. **107351-00011**.

Respectfully submitted,

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